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(54) LOW AMBIENT OPERATING PROCEDURE FOR COOLING SYSTEMS WITH HIGH EFFICIENCY CONDENSERS

VERFAHREN MIT GERINGER UMWELTNUTZUNG FÜR KÜHLSYSTEME MIT HOCHEFFIZIENTEN KONDENSATOREN

PROCÉDURE D'ACTIONNEMENT À ENVIRONNEMENT AMBIANT FAIBLE POUR SYSTÈMES DE REFROIDISSEMENT AVEC DES CONDENSEURS À RENDEMENT ÉLEVÉ

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Description

BACKGROUND

Technical Field:

[0001] Improved cooling systems with high-efficiency condensers are disclosed which provide improved performance at low ambient temperatures. Improved methods of operating cooling systems with high-efficiency condensers at low ambient temperatures are also disclosed.

Description of the Related Art:

[0002] As shown in FIG. 1, large commercial cooling systems like the one shown at 10 generally include an evaporator 11, an accumulator 12, one or more compressors 13, one or more condensers 14 and a throttling device or expansion valve 15. The system 10 illustrated in FIG. 1 is a dual system with one refrigerant circuit 11, 13, 14, 15 shown at the left in FIG. 1 and a corresponding refrigerant circuit 11a, 13a, 14a, 15a shown at the right in FIG. 1. Referring to the refrigerant circuit 11, 13, 15 shown at the left in FIG. 1, refrigerant flows through the continuous refrigerant loop 19 of the refrigerant circuit 11, 13, 14, 15. A heat transfer fluid is circulated through heat transfer tubing 16 in the evaporator 11 to transfer heat from the heat transfer fluid to refrigerant passing through the evaporator 11. Alternatively, heat may be transferred from the air in a climate controlled area to the refrigerant in the evaporator 11 by means of a forced air process. The heat transfer fluid chilled in the evaporator tubing 16 is normally water or glycol, which is circulated to a remote location to satisfy a cooling load. The refrigerant in the evaporator 11 evaporates as it absorbs heat from the heat transfer fluid, and the compressors 13 operate to extract and compress this refrigerant vapor, and to discharge the compressed vapor to the condenser 14. In the condenser 14, the refrigerant vapor is condensed and the liquid refrigerant is delivered back to the evaporator 11 through the throttling device 15, where the refrigerant cycle begins again.

[0003] There is an increasing demand for energy efficient cooling systems. In the system 10 illustrated in FIG. 1, system capacity is gained by employing multiple compressors 13. At lower ambient temperatures, only one or perhaps two of the three compressors 13 are utilized. Further, at lower ambient temperatures, only one of the two refrigerant circuits 11, 13, 14, 15 or 11a, 13a, 14a, 15a are utilized. System efficiency is also typically gained by adding more surface area to the condensers 14, 14a.

[0004] Still referring to the refrigerant circuit 11, 13, 14, 15 shown at the left in FIG. 1, the combined surface area provided by the large condenser coil surface areas 17, 18 increases efficiency of the system 10 at high ambient temperatures, by lowering the discharge pressure of compressor 13, thus lowering the electricity consumed

by compressor 13. This same concept also applies when the ambient temperature is low. Specifically, when a demand for air conditioning is made while the ambient temperature is low, the discharge pressure from the compressors 13 is too low, even with only one compressor 13 operating and the refrigerant cycle 11a, 13a, 14a, 15a shown at the right in FIG. 1 turned off. As a result, operation of the system 10 at low ambient temperatures cause the compressor 13 in the system to run outside of its safe operating range as the combination of low ambient temperatures and the high-efficiency condenser 14 design results in a great amount of heat being removed from the refrigerant cycle 11, 13, 14, 15 and discharged to the atmosphere which, in turn, results in lower than optimal discharge pressures at the lone compressor 13 that is operating. On one hand, unit software or low pressure switch may prevent the compressor 13 or system 10 from running at low ambient temperature conditions, to the dismay of the user. On the other hand, if the system 10 does operate at low ambient temperatures, compressor 13 failure may occur, also to the dismay of the user.

[0005] One way to operate the system 10 safely at low ambient temperature conditions is to lower airflow across the condenser 14, which reduces the heat removal through the condenser 14 thereby increasing discharge pressure to a safer level at the compressor 13. Therefore, in order to operate the system 10 at low ambient temperature conditions, variable speed motors 21, 22 need to be installed to control the speed of the fans 23, 24, which is expensive, labor intensive and requires a more complicated control system (not shown).

[0006] Accordingly, improved methods for operating cooling systems at low ambient temperatures and improved cooling systems systems that operate safely and efficiently at low ambient temperatures are desired.

[0007] US 6606872 B1 discloses a chiller system which includes at least two refrigerant circuits; in low ambient temperature conditions, only one refrigerant circuit is active.

[0008] US 3112620 discloses methods for controlling refrigeration and air conditioning systems at low outdoor temperatures.

SUMMARY OF THE DISCLOSURE

[0009] An improved multiple refrigerant circuit cooling system is disclosed that may be safely operated at low ambient temperatures, e.g., temperatures at or below about room temperature. One disclosed system comprises at least a first refrigerant circuit and a second refrigerant circuit. Each of said first and second refrigerant circuits comprises a compressor, a condenser and an evaporator connected in refrigerant flow communication. The condensers of the first and second refrigerant circuits each comprise condenser coils having exterior surfaces and each condenser comprising at least one fan for drawing ambient air across the exterior surfaces of its respective condenser coil. The exterior surfaces of the condens-

er coils of the condenser of the first refrigerant circuit being in fluid communication with the at least one fan of the condenser of the second refrigerant circuit to provide reduced airflow across the exterior surfaces of the condenser coil of the condenser of the first refrigerant circuit when a discharge pressure of the compressor of the first refrigerant circuit is below a compressor discharge pressure threshold value.

[0010] A method for operating the cooling system described above is also disclosed which comprises: receiving a demand for a cooling load; sensing the ambient temperature; when the ambient temperature is below a threshold value, activating the first refrigerant cycle without activating the second refrigerant cycle, deactivating the fan of the condenser of the first refrigerant cycle if the discharge pressure is below safe operating limit, and activating the fan of the condenser of the second refrigerant cycle, and, removing heat from the first refrigerant cycle by drawing a reduced air flow across the exterior surfaces of the condenser coil of the condenser of the first refrigerant using the fan of the condenser of the second refrigerant circuit.

[0011] Other advantages and features will be apparent from the following detailed description when read in conjunction with the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] For a more complete understanding of the disclosed methods and apparatuses, reference should be made to the embodiments illustrated in greater detail in the accompanying drawings, wherein:

FIG. 1 is a perspective and schematic view of a commercial cooling system with two refrigerant cycles;

FIG. 2 is a perspective and schematic view of a commercial cooling system with two refrigerant cycles and an improved control system and control scheme for reducing the airflow across one of the condensers when the ambient temperature is low;

FIG. 3 is a schematic illustration of the cooling system shown in FIG. 2; and

FIG. 4 graphically illustrates the improved discharge pressure at the compressor at low ambient temperatures (e.g., 0°C/32°F) when utilizing the cooling systems in accordance with FIGS. 2 and 3.

[0013] It should be understood that the drawings are not necessarily to scale and that the disclosed embodiments are sometimes illustrated diagrammatically and in partial views. In certain instances, details which are not necessary for an understanding of the disclosed methods and apparatuses or which render other details difficult to perceive may have been omitted. It should be understood, of course, that this disclosure is not limited to the

particular embodiments illustrated herein.

DETAILED DESCRIPTION OF THE PRESENTLY PREFERRED EMBODIMENTS

[0014] The HVAC industry is under heavy pressure to build and design energy efficient products. As noted above, multiple compressors, multiple evaporators and multiple refrigerant circuits are common design strategies. System efficiency is also typically gained by adding more surface area to the condensers 114, 114a illustrated in FIG. 2. One such strategy is to arrange the condenser coils in a v-shaped configuration with two condenser coil areas 117, 118 and 117a, 118a as illustrated in FIG. 2. Micro-channel heat exchanger type (MCHX) coils also increase efficiency of the condensers 114, 114a.

[0015] Low ambient temperatures will be defined as ambient temperatures at or about room temperature as well as below room temperature. For purposes of operating commercial air-conditioning systems, the term low ambient temperatures will refer to temperatures ranging from about freezing to about room temperature. Thus, for purposes of this disclosure, low ambient temperatures will range from about -17.8°C (0°F) to about 22°C (72°F).

[0016] In a typical operation at low ambient temperature, the system 110 will operate only one refrigerant cycle, such as the cycle 111, 113, 114, 115 while leaving the second refrigerant cycle 111a, 113a, 114a, 115a dormant or inactive. Further, only one of the three compressors 113 may be operating due to the decreased load requirements when operating a cooling system at low ambient temperatures. Even with only a single compressor 113 operating, the design strategies for increasing the efficiency of the condensers 114 at high ambient temperatures has an adverse effect on compressor operation at low ambient temperatures, because the increased surface areas 117, 118 draw too much heat from the refrigerant cycle 111, 113, 114, 115 thereby resulting in an insufficient discharge pressure at 26 from the compressor 113. If the discharge pressure 26 of the compressor 113 is too low, the compressor 113 may be operating outside of its normal or safe range and the compressor 113 may fail. Disclosed herein is system and method for using large surface area condensers like those shown at 114, 114a in FIG. 2 at low ambient temperatures, without sacrificing performance, efficiency or undue wear and tear on the compressors 113, 113a.

[0017] As shown in FIG. 2, the cooling system 110 is a split system with two refrigerant circuits including a first refrigerant circuit 111, 113, 114, 115 and a second refrigerant circuit 111a, 113a, 114a, 115a. Each evaporator 111, 111a is equipped evaporator tubing 116, 116a that transfers heat to the refrigerant in the refrigerant tubing 119, 119a. The compressors 113, 113a may be linked to the controller 25 and compressor discharge pressure sensors 26, 26a (see FIG. 3) may also be linked to the controller 25, although in practice, the disclosed system

110 and associated methods, only one compressor discharge sensor 26 may be desired because, at low ambient temperatures, as only one of the two refrigerant circuits 111, 113, 114, 115 will be operational.

[0018] At low ambient temperatures, as measured by the ambient temperature sensor 27, the controller 25 will operate only one of the refrigerant cycles, in this example, the refrigerant cycle 111, 113, 114, 115 shown at the left in FIG. 2. The second refrigerant cycle 111a, 113a, 114a, 115a remains idle. However, the controller 25 also operates the fan motors 121, 122 and 121a, 122a. In this disclosed system 110, the fan motors 121, 122, 121a, 122a may be single stage or constant speed motors as variable speed motors and variable speed drives are not necessary for the reasons explained herein. The use of single speed motors 121, 122, 121a, 122a are less expensive, require a simpler and less expensive control system and are easier to operate and maintain than variable speed motors.

[0019] To reduce the airflow through the energy-efficient condenser 114, the fan motors 121, 122 are deactivated by the controller 25 and the fan motors 121a, 122a of the compressor 114a of the idle refrigerant cycle 111a, 113a, 114a, 115a are activated by the controller 25 without activating the compressors 113a or pump or fan (not shown) associated with the evaporator 111a.

[0020] Referring to FIG. 2, the condensers 114, 114a are preferably arranged in a side-by-side fashion. As a result, activation of the fan motors 121a, 122a will draw air through the panels 117, 118 of the activated condenser 114, up through the panel 118a of the deactivated condenser 114a and through one or more of the fans 123a, 124a of the deactivated condenser 114a. This airflow scheme results in reduced airflow across the exterior surfaces of the heat exchanger coils of the activated condenser 114 thereby reducing the heat transfer of the condenser 114 at low ambient temperatures without a significant increase in energy usage. As a result, with the reduced heat transfer of the condenser 114, the discharge pressure at the compressor 113 is maintained at an acceptably high level thereby reducing the risks associated with operating the compressor 113 at unacceptably low discharge pressures.

[0021] FIG. 3 is a simplified schematic illustration of the system 110 of FIG. 2. The controller 25 may be linked to a plurality of inputs and devices including the ambient temperature sensor 27, the motors 133 133a of the compressors 113, 113a, the expansion valves 115, 115a, the fan motors 121, 121a and pumps or fans (not shown) associated with the evaporators 111, 111a. As noted above, more than two evaporators 111, 111a, more than two compressors 113, 113a and more than two condensers 114, 114a may be employed. In addition to discharge pressure sensors 26, 26a, the controller 25 may be linked to compressor input pressure sensors 126, 126a as well to provide a pressure drop reading across each compressor 113, 113a. However, in practicing the principles of this disclosure, it may be necessary only to obtain one

of: an ambient temperature reading of the sensor 27; a discharge pressure reading at the sensor 26; a combination of ambient temperature at 27 and discharge pressure at 26; a pressure drop between the sensors 126, 26; or combination of ambient temperature at 27 and pressure drop across the sensors 126, 26. Various techniques for determining the appropriate ambient temperature or other operating condition at which to run the system 110 using one condenser 114 and one or more fans 123a, 124a of an idle condenser 114a can be employed as will be apparent to those skilled in the art.

[0022] The benefits of utilizing this cooling system 110 and methods of operating the cooling system 110 disclosed herein are illustrated in FIG. 4, which compares operation of the system 110 (FIGS. 2-3) with the prior art system 10 (FIG. 1). Data points were taken over an extended interval at an ambient temperature of about 0°C (32°F). The system startup is indicated at 135. In the prior art system 10, the suction pressure is indicated at 136 and the discharge pressure is indicated at 137. Obviously, the pressure drop between the suction 136 and discharge 137 pressures is insufficient and the compressor discharge pressure 137 is unacceptably low. In contrast, utilizing the disclosed system 110, the compressor suction pressure is indicated at 138 and the compressor discharge pressure at 139. Operating a single refrigerant circuit such as the one shown at 111, 113, 114, 115 in FIGS. 2-3 and utilizing the fan 123a of an adjacent idle condenser 114a sufficiently decreases the heat transfer of the condenser 114 without a significant increase in energy usage and results in an increase in the discharge pressure as indicated at 139 and FIG. 4. As a result, the system 110 can be operated safely at ambient temperatures below room temperature and even ambient temperatures approaching and below freezing by operating a single refrigerant circuit and utilizing the fan or air pump of an adjacent idle condenser to draw the cool ambient air across the condenser that is in use.

[0023] By utilizing the airflow from the "off" refrigerant circuit 111a, 113a, 114a, 115a to increase the compressor 113 discharge pressure in the "on" circuit 111, 113, 114, 115, large systems 110 with multiple "V" condenser sections 114, 114a can be operated safely at low ambient temperatures without a significant increase in energy usage. Using the airflow from the "on" refrigerant circuit 111, 113, 114, 115 results in too much airflow across the condenser 114 at low outside temperatures, which lower the compressor 113 discharge pressure 26, falling below the safe operating range of the typical compressor 113. However, using one or more of the fans 123a, 124a from the "off" circuit 111a, 113a, 114a, 115 "steals" enough air from the "on" circuit 111, 113, 114, 115 to run the system 110 at acceptable compressor 113 discharge pressures 26 as illustrated at 139 in FIG. 4.

[0024] The system 110 and control methods described above provide increased compressor 113 discharge pressures 26 at low outside air temperatures without the use of any additional installed items such as variable

speed motors, variable speed drives or the control systems associated therewith. All that is required is a simplified control or software that activates at least one fan 123a or 124a from the "off" circuit 111a, 113a, 114a, 115a instead of the fans 123, 124 from the "on" circuit 111, 113, 114, 115 when the system 110 is operated at low ambient temperatures. No additional parts or unit costs are associated with the disclosed systems 110 and methods of operation thereof.

[0025] While only certain embodiments have been set forth, alternatives and modifications will be apparent from the above description to those skilled in the art. These and other alternatives are considered equivalents and within the scope of this disclosure and the appended claims.

Claims

1. A multiple refrigerant circuit cooling system (110) comprising:

at least a first refrigerant circuit (111, 113, 114, 115) and a second refrigerant circuit (111a, 113a, 114a, 115a), each of said first and second refrigerant circuits (111, 113, 114, 115, 111a, 113a, 114a, 115a) comprising a compressor (113, 113a), a condenser (114, 114a), an expansion device (115, 115a) and an evaporator (111, 111a) connected in refrigerant flow communication; and

the condensers (114, 114a) of the first and second refrigerant circuits (111, 113, 114, 115, 111a, 113a, 114a, 115a) each comprising condenser coils having exterior surfaces (117, 118, 117a, 118a) and each condenser (114, 114a) comprising at least one fan (123, 124, 123a, 124a) for drawing ambient air across the exterior surfaces (117, 118, 117a, 118a) of its respective condenser coil;

characterised in that

the exterior surfaces (117, 118) of the condenser coil of the condenser (114) of the first refrigerant circuit (111, 113, 114, 115) being in fluid communication with the at least one fan (123a, 124a) of the condenser (114a) of the second refrigerant circuit (111a, 113a, 114a, 115a) to provide reduced airflow across the exterior surfaces (117, 118) of the condenser coil of the condenser of the first refrigerant circuit (111, 113, 114, 115) when a discharge pressure of the compressor (113) of the first refrigerant circuit (111, 113, 114, 115) is below a compressor discharge pressure threshold value.

2. The system (110) of claim 1 further comprising a controller (25) linked to an ambient temperature sensor (27), the first and second refrigerant circuits (111,

113, 114, 115, 111a, 113a, 114a, 115a) and the at least one fan (123, 124, 123a, 124a) of the condensers (114, 114a) of the first and second refrigerant circuits (111, 113, 114, 115, 111a, 113a, 114a, 115a),

the controller (25) being configured to deactivate the second refrigerant circuit (111a, 113a, 114a, 115a) when an ambient temperature measured by the ambient temperature sensor (27) is below a first threshold value.

3. The system (110) of claim 1 further comprising a controller (25) linked to a discharge pressure sensor (26) to measure the discharge pressure of the compressor (113) of the first refrigerant circuit (111, 113, 114, 115), the controller (25) further being linked to the first and second refrigerant circuits (111, 113, 114, 115, 111a, 113a, 114a, 115a) and the at least one fan (123, 124, 123a, 124a) of the condensers (114, 114a) of the first and second refrigerant circuits (111, 113, 114, 115, 111a, 113a, 114a, 115a), the controller (25) further being configured to deactivate the at least one fan (123, 124) of the condenser (114) of the first refrigerant circuit (111, 113, 114, 115) and to activate the at least one fan (123a, 124a) of the second refrigerant circuit (111a, 113a, 114a, 115a) when the discharge pressure (26) of the compressor (113) of the first refrigerant circuit (111, 113, 114, 115) is below the compressor discharge pressure threshold value.
4. The system (110) of claim 1 wherein the condenser coils of the condensers (114, 114a) of the first and second refrigerant circuit (111a, 113a, 114a, 115a)s are arranged in a v-shaped configuration.
5. The system (110) of claim 4 wherein the condensers (114, 114a) of the first and second refrigerant circuit (111, 113, 114, 115, 111a, 113a, 114a, 115a) are arranged in a side-by-side configuration.
6. The system (110) of claim 4 wherein the condenser coils (117, 118, 117a, 118a) of the condensers (114, 114a) of the first and second refrigerant circuits (111, 113, 114, 115, 111a, 113a, 114a, 115a) are micro-channel heat exchanger (MCHX) coils.
7. The system (110) of claim 1 wherein the at least one fan of each of the condenser (114, 114a) of the first and second refrigerant circuits (111, 113, 114, 115, 111a, 113a, 114a, 115a) has connected thereto a constant speed motor (121, 122, 121a, 122a), each constant speed motor (121, 122, 121a, 122a) being linked to a controller (25), the controller (25) configured to deactivate the constant speed motor (121, 122) of the condenser (114) of the first refrigerant circuit (111, 113, 114, 115) and to activate the constant speed motor (121a, 122a)

of the condenser (114a) of the second refrigerant circuit (111a, 113a, 114a, 115a) when the discharge pressure is below the compressor discharge pressure threshold value.

8. The system (110) of claim 1 wherein the at least one fan of each of the condenser (114, 114a) of the first and second refrigerant circuits (111, 113, 114, 115, 111a, 113a, 114a, 115a) has connected thereto a constant speed motor (121, 122, 121a, 122a), each constant speed motor (121, 122, 121a, 122a) being linked to a controller (25), the controller (25) configured to deactivate the constant speed motor (121, 122) of the condenser (114) of the first refrigerant circuit (111, 113, 114, 115) and to activate the constant speed motor (121a, 122a) of the condenser (114a) of the second refrigerant circuit (111a, 113a, 114a, 115a) when a pressure drop between a suction pressure and the discharge pressure (26) of the compressor (113) of the first refrigerant circuit (111, 113, 114, 115) is below a second threshold value.
9. The system (110) of claim 2, 3, 7 or 8, wherein the first refrigerant circuit (111, 113, 114, 115) comprises a plurality of compressors (113) and the controller (25) being programmed to deactivate all but one of the plurality of compressors (113) of the first refrigerant circuit (111, 113, 114, 115) when the ambient temperature (27) is below the first threshold value.
10. The system (110) of claim 2 wherein the ambient temperature (27) is defined as being less than or equal to about 22°C.
11. The system (110) of claim 2 wherein the first threshold value is less than or equal to about 22°C.
12. A method for operating a cooling system (110) that includes a first refrigerant circuit (111, 113, 114, 115) and an adjacent second refrigerant circuit (111a, 113a, 114a, 115a), the method comprising:

receiving a demand for a cooling load;
activating the first refrigerant circuit (111, 113, 114, 115);

characterised by

sensing a discharge pressure (26) at a compressor (113) of the first refrigerant circuit (111, 113, 114, 115), and when the discharge pressure (26) at the compressor (113) of the first refrigerant circuit (111, 113, 114, 115) is below a compressor discharge pressure threshold value, deactivating a fan (123, 124) of a condenser (114) of the first refrigerant circuit (111, 113, 114, 115) and activating a fan (123a, 124a) of a condenser (114a) of the adjacent second refrigerant circuit (111a, 113a, 114a, 115a); and

removing heat from the first refrigerant circuit (111, 113, 114, 115) by drawing a reduced air flow across the condenser (114) of the first refrigerant circuit (111, 113, 114, 115) using the fan (123a, 124a) of the condenser (114a) of the second refrigerant circuit (111a, 113a, 114a, 115a).

13. The method of claim 12 wherein the activating of the first refrigerant circuit (111, 113, 114, 115) further comprises activating the first refrigerant circuit (111, 113, 114, 115) without activating the second refrigerant circuit (111a, 113a, 114a, 115a) when an ambient temperature (27) is below a first threshold value.
14. The method of claim 12 wherein an ambient temperature (27) is less than or about room temperature, and upon receiving said demand for a cooling load;
sensing the ambient temperature (27), and when the ambient temperature (27) is less than or about room temperature, activating the first refrigerant circuit (111, 113, 114, 115) without activating the second refrigerant circuit (111a, 113a, 114a, 115a); and deactivating the fan (123, 124) of the condenser (114) of the first refrigerant circuit (111, 113, 114, 115) and activating the fan (123a, 124a) of the condenser (114a) of the second refrigerant circuit (111a, 113a, 114a, 115a) without activating the second refrigerant circuit (111a, 113a, 114a, 115a).
15. The method of claim 12 or 14, wherein the first refrigerant circuit (111, 113, 114, 115) comprises a plurality of compressors (113), and the method further comprises deactivating all but one of the compressors (113) of the first refrigerant circuit (111, 113, 114, 115) when the ambient temperature (27) is less than or about room temperature.

Patentansprüche

1. KÜHLSYSTEM mit mehreren Kältemittelkreisläufen (110), umfassend:

mindestens einen ersten Kältemittelkreislauf (111, 113, 114, 115) und einen zweiten Kältemittelkreislauf (111a, 113a, 114a, 115a), wobei jeder aus dem ersten und dem zweiten Kältemittelkreislauf (111, 113, 114, 115, 111a, 113a, 114a, 115a) einen Kompressor (113, 113a), einen Kondensator (114, 114a), ein Expansionsorgan (115, 115a) und einen Verdampfer (111, 111a) umfasst, die in Kältemittelströmungsver-

- bindung stehen; und
wobei die Kondensatoren (114, 114a) des ersten und des zweiten Kältemittelkreislaufs (111, 113, 114, 115, 111a, 113a, 114a, 115a) jeweils
5 Kondensatorschlangen umfassen, die Außenflächen (117, 118, 117a, 118a) aufweisen, und
wobei jeder Kondensator (114, 114a) mindestens ein Gebläse (123, 124, 123a, 124a) umfasst, um Umgebungsluft über die Außenflächen (117, 118, 117a, 118a) seiner jeweiligen
10 Kondensatorschlange zu ziehen;
dadurch gekennzeichnet, dass
die Außenflächen (117, 118) der Kondensatorschlange des Kondensators (114) des ersten
Kältemittelkreislaufs (111, 113, 114, 115) in Fluidverbindung mit dem mindestens einen Gebläse
(123a, 124a) des Kondensators (114a) des zweiten Kältemittelkreislaufs (111a, 113a,
114a, 115a) stehen, um einen verminderten Luftstrom über die Außenflächen (117, 118) der
20 Kondensatorschlange des Kondensators des ersten Kältemittelkreislaufs (111, 113, 114, 115)
bereitzustellen, wenn ein Austrittsdruck des Kompressors (113) des ersten Kältemittelkreislaufs
(111, 113, 114, 115) unter einem Schwellenwert für den Austrittsdruck des Kompressors
25 liegt.
2. System (110) nach Anspruch 1, weiter umfassend eine Steuereinheit (25), die mit einem Umgebungstemperatursensor (27), dem ersten und dem zweiten
30 Kältemittelkreislauf (111, 113, 114, 115, 111a, 113a, 114a, 115a) und dem mindestens einen Gebläse
(123, 124, 123a, 124a) der Kondensatoren (114, 114a) des ersten und des zweiten Kältemittelkreislaufs
(111, 113, 114, 115, 111a, 113a, 114a, 115a) verbunden ist,
35 wobei die Steuereinheit (25) konfiguriert ist, um den zweiten Kältemittelkreislauf (111a, 113a, 114a,
115a) zu deaktivieren, wenn eine vom Umgebungstemperatursensor (27) gemessene Umgebungstemperatur
unter einem ersten Schwellenwert liegt.
 3. System (110) nach Anspruch 1, weiter umfassend eine Steuereinheit (25), die mit einem Austrittsdruck-
45 sensor (26) verbunden ist, um den Austrittsdruck des Kompressors (113) des ersten Kältemittelkreislaufs
(111, 113, 114, 115) zu messen, wobei die Steuereinheit (25) weiter mit dem ersten und dem zweiten
Kältemittelkreislauf (111, 113, 114, 115, 111a, 113a, 114a, 115a) und dem mindestens einen Gebläse
(123, 124, 123a, 124a) der Kondensatoren (114, 114a) des ersten und des zweiten Kältemittel-
50 kreislaufs (111, 113, 114, 115, 111a, 113a, 114a, 115a) verbunden ist,
wobei die Steuereinheit (25) weiter konfiguriert ist, um das mindestens eine Gebläse (123, 124) des
Kondensators (114) des ersten Kältemittelkreislaufs
(111, 113, 114, 115) zu deaktivieren und das mindestens eine Gebläse (123a, 124a) des zweiten Kältemittelkreislaufs
(111a, 113a, 114a, 115a) zu aktivieren, wenn der Austrittsdruck (26) des Kompressors (113) des ersten Kältemittelkreislaufs (111,
113, 114, 115) unter dem Schwellenwert für den Austrittsdruck des Kompressors liegt.
 4. System (110) nach Anspruch 1, wobei die Kondensatorschlangen der Kondensatoren (114, 114a) des
10 ersten und des zweiten Kältemittelkreislaufs (111a, 113a, 114a, 115a) in einer V-förmigen Konfiguration
angeordnet sind.
 5. System (110) nach Anspruch 4, wobei die Kondensatoren (114, 114a) des ersten und des zweiten Kältemittelkreislaufs
(111, 113, 114, 115, 111a, 113a, 114a, 115a) in einer nebeneinanderliegenden Konfiguration
15 angeordnet sind.
 6. System (110) nach Anspruch 4, wobei die Kondensatorschlangen (117, 118, 117a, 118a) der Kondensatoren
(114, 114a) des ersten und des zweiten Kältemittelkreislaufs (111, 113, 114, 115, 111a, 113a,
114a, 115a) Mikrokanal-Wärmetauscher-Schlangen (MCHX) sind.
 7. System (110) nach Anspruch 1, wobei das mindestens eine Gebläse jedes der Kondensatoren (114,
30 114a) des ersten und des zweiten Kältemittelkreislaufs (111, 113, 114, 115, 111a, 113a, 114a, 115a)
mit einem Motor mit konstanter Drehzahl (121, 122, 121a, 122a) verbunden ist, wobei jeder Motor mit
konstanter Drehzahl (121, 122, 121a, 122a) mit einer Steuereinheit (25) verbunden ist,
35 wobei die Steuereinheit (25) konfiguriert ist, um den Motor mit konstanter Drehzahl (121, 122) des Kondensators
(114) des ersten Kältemittelkreislaufs (111, 113, 114, 115) zu deaktivieren und den Motor mit konstanter
Drehzahl (121a, 122a) des Kondensators (114a) des zweiten Kältemittelkreislaufs (111a, 113a, 114a, 115a)
zu aktivieren, wenn der Austrittsdruck unter dem Schwellenwert für den Austrittsdruck des Kompressors
40 liegt.
 8. System (110) nach Anspruch 1, wobei das mindestens eine Gebläse jedes der Kondensatoren (114,
114a) des ersten und des zweiten Kältemittelkreislaufs (111, 113, 114, 115, 111a, 113a, 114a, 115a)
mit einem Motor mit konstanter Drehzahl (121, 122, 121a, 122a) verbunden ist, wobei jeder Motor mit
konstanter Drehzahl (121, 122, 121a, 122a) mit einer Steuereinheit (25) verbunden ist,
50 wobei die Steuereinheit (25) konfiguriert ist, um den Motor mit konstanter Drehzahl (121, 122) des Kondensators
(114) des ersten Kältemittelkreislaufs (111, 113, 114, 115) zu deaktivieren und den Motor mit konstanter
Drehzahl (121a, 122a) des Kondensators (114a) des zweiten Kältemittelkreislaufs (111a, 113a, 114a, 115a)
zu aktivieren, wenn der Austrittsdruck unter dem Schwellenwert für den Austrittsdruck des Kompressors
55 liegt.

sators (114a) des zweiten Kältemittelkreislaufs (111a, 113a, 114a, 115a) zu aktivieren, wenn eine Druckdifferenz zwischen einem Ansaugdruck und dem Austrittsdruck (26) des Kompressors (113) des ersten Kältemittelkreislaufs (111, 113, 114, 115) unter einem zweiten Schwellenwert liegt.

9. System (110) nach Anspruch 2, 3, 7 oder 8, wobei der erste Kältemittelkreislauf (111, 113, 114, 115) eine Vielzahl von Kompressoren (113) umfasst und die Steuereinheit (25) programmiert ist, um alle bis auf einen aus der Vielzahl von Kompressoren (113) des ersten Kältemittelkreislaufs (111, 113, 114, 115) zu deaktivieren, wenn die Umgebungstemperatur (27) unter dem ersten Schwellenwert liegt.
10. System (110) nach Anspruch 2, wobei die Umgebungstemperatur (27) als etwa 22 °C oder weniger definiert ist.
11. System (110) nach Anspruch 2, wobei der erste Schwellenwert etwa 22 °C oder weniger ist.
12. Verfahren zum Betreiben eines Kühlsystems (110), das einen ersten Kältemittelkreislauf (111, 113, 114, 115) und einen angrenzenden zweiten Kältemittelkreislauf (111a, 113a, 114a, 115a) umfasst, wobei das Verfahren Folgendes umfasst:

Empfangen einer Anforderung zum Abführen einer Wärmemenge;
Aktivieren des ersten Kältemittelkreislaufs (111, 113, 114, 115);

gekennzeichnet durch

Erfassen eines Austrittsdrucks (26) an einem Kompressor (113) des ersten Kältemittelkreislaufs (111, 113, 114, 115), und wenn der Austrittsdruck (26) am Kompressor (113) des ersten Kältemittelkreislaufs (111, 113, 114, 115) unter einem Schwellenwert für den Austrittsdruck des Kompressors liegt, Deaktivieren eines Gebläses (123, 124) eines Kondensators (114) des ersten Kältemittelkreislaufs (111, 113, 114, 115) und Aktivieren eines Gebläses (123a, 124a) eines Kondensators (114a) des angrenzenden zweiten Kältemittelkreislaufs (111a, 113a, 114a, 115a); und
Abführen von Wärme aus dem ersten Kältemittelkreislauf (111, 113, 114, 115) durch Ziehen eines verringerten Luftstroms über den Kondensator (114) des ersten Kältemittelkreislaufs (111, 113, 114, 115) unter Verwendung des Gebläses (123a, 124a) des Kondensators (114a) des zweiten Kältemittelkreislaufs (111a, 113a, 114a, 115a).

13. Verfahren nach Anspruch 12, wobei das Aktivieren des ersten Kältemittelkreislaufs (111, 113, 114, 115)

weiter das Aktivieren des ersten Kältemittelkreislaufs (111, 113, 114, 115) ohne Aktivieren des zweiten Kältemittelkreislaufs (111a, 113a, 114a, 115a) umfasst, wenn eine Umgebungstemperatur (27) unter einem ersten Schwellenwert liegt.

14. Verfahren nach Anspruch 12, wobei eine Umgebungstemperatur (27) etwa bei Raumtemperatur oder darunter liegt, und umfassend nach dem Empfangen der Anforderung zum Abführen einer Wärmemenge das Erfassen der Umgebungstemperatur (27), und wenn die Umgebungstemperatur (27) etwa bei Raumtemperatur oder darunter liegt, Aktivieren des ersten Kältemittelkreislaufs (111, 113, 114, 115) ohne Aktivieren des zweiten Kältemittelkreislaufs (111a, 113a, 114a, 115a); und Deaktivieren des Gebläses (123, 124) des Kondensators (114) des ersten Kältemittelkreislaufs (111, 113, 114, 115) und Aktivieren des Gebläses (123a, 124a) des Kondensators (114a) des zweiten Kältemittelkreislaufs (111a, 113a, 114a, 115a) ohne Aktivieren des zweiten Kältemittelkreislaufs (111a, 113a, 114a, 115a).

15. Verfahren nach Anspruch 12 oder 14, wobei der erste Kältemittelkreislauf (111, 113, 114, 115) eine Vielzahl von Kompressoren (113) umfasst und das Verfahren weiter das Deaktivieren aller bis auf einen der Kompressoren (113) des ersten Kältemittelkreislaufs (111, 113, 114, 115) umfasst, wenn die Umgebungstemperatur (27) etwa bei Raumtemperatur oder darunter liegt.

Revendications

1. Système de refroidissement de multiple circuit de fluide frigorigène (110) comprenant :

au moins un premier circuit de fluide frigorigène (111, 113, 114, 115) et un second circuit de fluide frigorigène (111a, 113a, 114a, 115a), chacun desdits premier et second circuits de fluide frigorigène (111, 113, 114, 115, 111a, 113a, 114a, 115a) comprenant un compresseur (113, 113a), un condenseur (114, 114a), un dispositif de détente (115, 115a) et un évaporateur (111, 111a) raccordés en communication d'écoulement de fluide frigorigène ; et

les condenseurs (114, 114a) des premier et second circuits de fluide frigorigène (111, 113, 114, 115, 111a, 113a, 114a, 115a) comprenant chacun des bobines de condenseur ayant des surfaces extérieures (117, 118, 117a, 118a) et chaque condenseur (114, 114a) comprenant au moins un ventilateur (123, 124, 123a, 124a) pour aspirer l'air ambiant à travers les surfaces exté-

rieures (117, 118, 117a, 118a) de sa bobine de condenseur respective ;

caractérisé en ce que

les surfaces extérieures (117, 118) de la bobine de condenseur du condenseur (114) du premier circuit de fluide frigorigène (111, 113, 114, 115) étant en communication fluïdique avec l'au moins un ventilateur (123a, 124a) du condenseur (114a) du second circuit de fluide frigorigène (111a, 113a, 114a, 115a) pour fournir un écoulement d'air réduit à travers les surfaces extérieures (117, 118) de la bobine de condenseur du condenseur du premier circuit de fluide frigorigène (111, 113, 114, 115) lorsqu'une pression de refoulement du compresseur (113) du premier circuit de fluide frigorigène (111, 113, 114, 115) est en dessous d'une valeur seuil de pression de refoulement de compresseur.

2. Système (110) selon la revendication 1, comprenant en outre un dispositif de commande (25) lié à un capteur de température ambiante (27), aux premier et second circuits de fluide frigorigène (111, 113, 114, 115, 111a, 113a, 114a, 115a) et à l'au moins un ventilateur (123, 124, 123a, 124a) des condenseurs (114, 114a) des premier et second circuits de fluide frigorigènes (111, 113, 114, 115, 111a, 113a, 114a, 115a), le dispositif de commande (25) étant configuré pour désactiver le second circuit de fluide frigorigène (111a, 113a, 114a, 115a) lorsqu'une température ambiante mesurée par le capteur de température ambiante (27) est en dessous d'une première valeur seuil.
3. Système (110) selon la revendication 1, comprenant en outre un dispositif de commande (25) lié à un capteur de pression de refoulement (26) pour mesurer la pression de refoulement du compresseur (113) du premier circuit de fluide frigorigène (111, 113, 114, 115), le dispositif de commande (25) étant en outre lié aux premier et second circuits de fluide frigorigène (111, 113, 114, 115, 111a, 113a, 114a, 115a) et à l'au moins un ventilateur (123, 124, 123a, 124a) des condenseurs (114, 114a) des premier et second circuits de fluide frigorigène (111, 113, 114, 115, 111a, 113a, 114a, 115a), le dispositif de commande (25) étant en outre configuré pour désactiver l'au moins un ventilateur (123, 124) du condenseur (114) du premier circuit de fluide frigorigène (111, 113, 114, 115) et pour activer l'au moins un ventilateur (123a, 124a) du second circuit de fluide frigorigène (111a, 113a, 114a, 115a) lorsque la pression de refoulement (26) du compresseur (113) du premier circuit de fluide frigorigène (111, 113, 114, 115) est en dessous de la seconde valeur de seuil de pression de refoulement de compresseur.

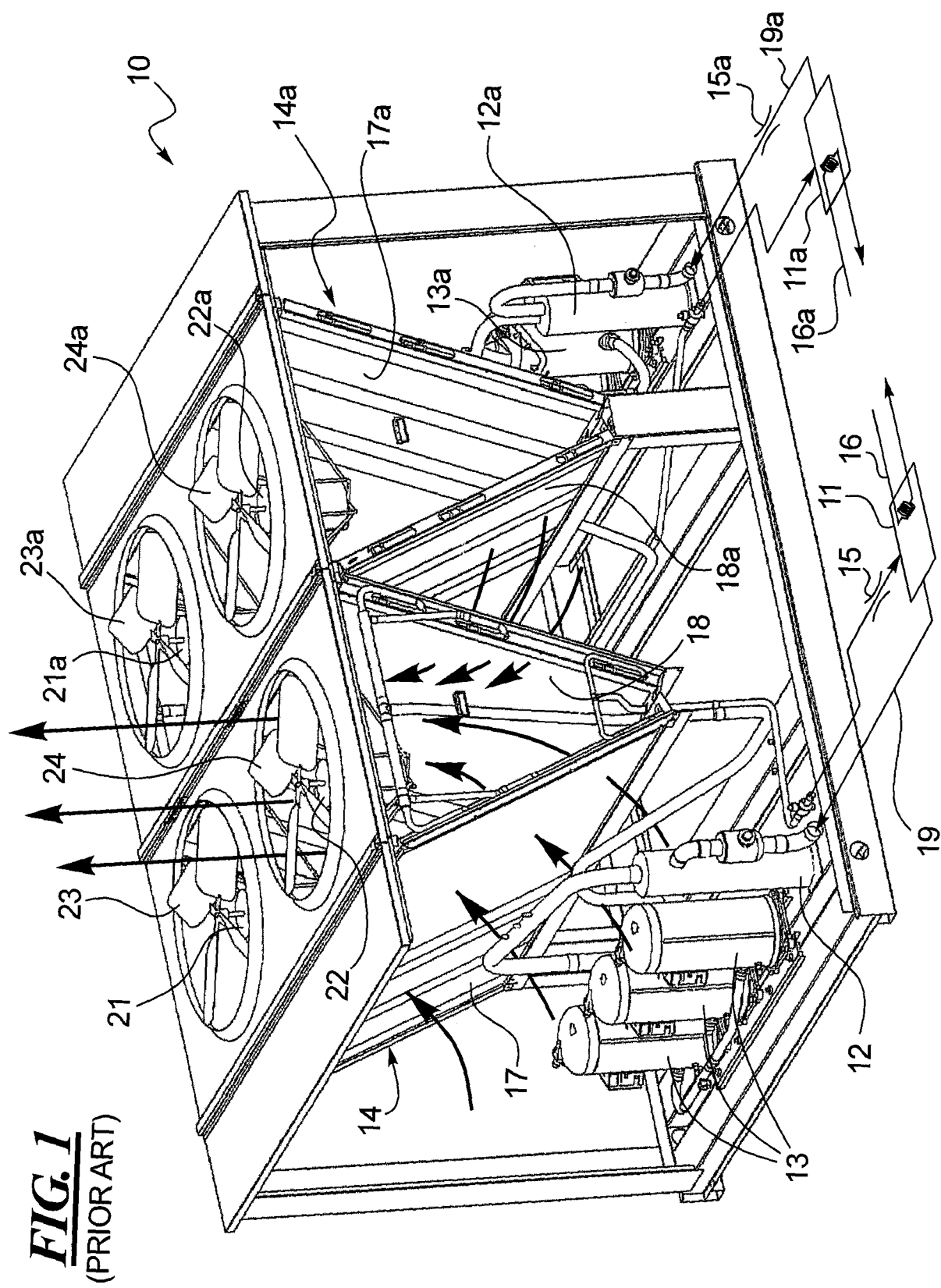
4. Système (110) selon la revendication 1, dans lequel les bobines de condenseur des condenseurs (114, 114a) des premier et second circuits de fluide frigorigène (111a, 113a, 114a, 115a) sont agencées selon une configuration en forme de V.
5. Système (110) selon la revendication 4, dans lequel les condenseurs (114, 114a) des premier et second circuits de fluide frigorigène (111, 113, 114, 115, 111a, 113a, 114a, 115a) sont agencés selon une configuration côte à côte.
6. Système (110) selon la revendication 4, dans lequel les bobines de condenseur (117, 118, 117a, 118a) des condenseurs (114, 114a) des premier et second circuits de fluide frigorigène (111, 113, 114, 115, 111a, 113a, 114a, 115a) sont des bobines d'échangeur de chaleur à micro-canal (MCHX).
7. Système (110) selon la revendication 1, dans lequel l'au moins un ventilateur de chacun des condenseurs (114, 114a) des premier et second circuits de fluide frigorigène (111, 113, 114, 115, 111a, 113a, 114a, 115a) est raccordé à un moteur à vitesse constante (121, 122, 121a, 122a), chaque moteur à vitesse constante (121, 122, 121a, 122a) étant lié à un dispositif de commande (25), le dispositif de commande (25) est configuré pour désactiver le moteur à vitesse constante (121, 122) du condenseur (114) du premier circuit de fluide frigorigène (111, 113, 114, 115) et pour activer le moteur à vitesse constante (121a, 122a) du condenseur (114a) du second circuit de fluide frigorigène (111a, 113a, 114a, 115a) lorsque la pression de refoulement est en dessous de la valeur seuil de pression de refoulement de compresseur.
8. Système (110) selon la revendication 1, dans lequel l'au moins un ventilateur de chacun des condenseurs (114, 114a) des premier et second circuits de fluide frigorigène (111, 113, 114, 115, 111a, 113a, 114a, 115a) est raccordé à un moteur à vitesse constante (121, 122, 121a, 122a), chaque moteur à vitesse constante (121, 122, 121a, 122a) étant lié à un dispositif de commande (25), le dispositif de commande (25) est configuré pour désactiver le moteur à vitesse constante (121, 122) du condenseur (114) du premier circuit de fluide frigorigène (111, 113, 114, 115) et pour activer le moteur à vitesse constante (121a, 122a) du condenseur (114a) du second circuit de fluide frigorigène (111a, 113a, 114a, 115a) lorsqu'une chute de pression entre une pression d'aspiration et la pression de refoulement (26) du compresseur (113) du premier circuit de fluide frigorigène (111, 113, 114, 115) est en dessous d'une seconde valeur seuil.
9. Système (110) selon la revendication 2, 3, 7 ou 8,

dans lequel le premier circuit de fluide frigorigène (111, 113, 114, 115) comprend une pluralité de compresseurs (113) et le dispositif de commande (25) étant programmé pour désactiver tous sauf un de la pluralité de compresseurs (113) du premier circuit de fluide frigorigène (111, 113, 114, 115) lorsque la température ambiante (27) est en dessous de la première valeur seuil.

10. Système (110) selon la revendication 2, dans lequel la température ambiante (27) est définie comme étant inférieure ou égale à environ 22 °C. 10
11. Système (110) selon la revendication 2, dans lequel la première valeur seuil est inférieure ou égale à environ 22 °C. 15
12. Procédé d'actionnement d'un système de refroidissement (110) qui comporte un premier circuit de fluide frigorigène (111, 113, 114, 115) et un second circuit de fluide frigorigène adjacent (111a, 113a, 114a, 115a), le procédé comprenant : 20
la réception d'un ordre d'une charge de refroidissement ; 25
l'activation du premier circuit de fluide frigorigène (111, 113, 114, 115) ;
caractérisé par
la détection d'une pression de refoulement (26) au niveau d'un compresseur (113) du premier circuit de fluide frigorigène (111, 113, 114, 115), et lorsque la pression de refoulement (26) au niveau du compresseur (113) du premier circuit de fluide frigorigène (111, 113, 114, 115) est en dessous d'une valeur seuil de pression de refoulement de compresseur, 30
la désactivation d'un ventilateur (123, 124) d'un condenseur (114) du premier circuit de fluide frigorigène (111, 113, 114, 115) et l'activation d'un ventilateur (123a, 124a) d'un condenseur (114a) du second circuit de fluide frigorigène adjacent (111a, 113a, 114a, 115a) ; et 40
l'élimination de chaleur du premier circuit de fluide frigorigène (111, 113, 114, 115) en aspirant un écoulement d'air réduit à travers le condenseur (114) du premier circuit de fluide frigorigène (111, 113, 114, 115) à l'aide du ventilateur (123a, 124a) du condenseur (114a) du second circuit de fluide frigorigène (111a, 113a, 114a, 115a). 45
50
13. Procédé selon la revendication 12, dans lequel l'activation du premier circuit de fluide frigorigène (111, 113, 114, 115) comprend en outre l'activation du premier circuit de fluide frigorigène (111, 113, 114, 115) sans activer le second circuit de fluide frigorigène (111a, 113a, 114a, 115a) lorsqu'une température ambiante (27) est en dessous d'une première valeur 55

seuil.

14. Procédé selon la revendication 12, dans lequel une température ambiante (27) est inférieure à une température ordinaire ou proche de celle-ci, et lors de la réception dudit ordre d'une charge de refroidissement ; la détection de la température ambiante (27), et lorsque la température ambiante (27) est inférieure à la température ordinaire ou proche de celle-ci, l'activation du premier circuit de fluide frigorigène (111, 113, 114, 115) sans activer le second circuit de fluide frigorigène (111a, 113a, 114a, 115a) ; et la désactivation du ventilateur (123, 124) du condenseur (114) du premier circuit de fluide frigorigène (111, 113, 114, 115) et l'activation du ventilateur (123a, 124a) du condenseur (114a) du second circuit de fluide frigorigène (111a, 113a, 114a, 115a) sans activer le second circuit de fluide frigorigène (111a, 113a, 114a, 115a).
15. Procédé selon la revendication 12 ou 14, dans lequel le premier circuit de fluide frigorigène (111, 113, 114, 115) comprend une pluralité de compresseurs (113), et le procédé comprend en outre la désactivation de tous les compresseurs (113) sauf un du premier circuit de fluide frigorigène (111, 113, 114, 115) lorsque la température ambiante (27) est inférieure à la température ordinaire ou proche de celle-ci.



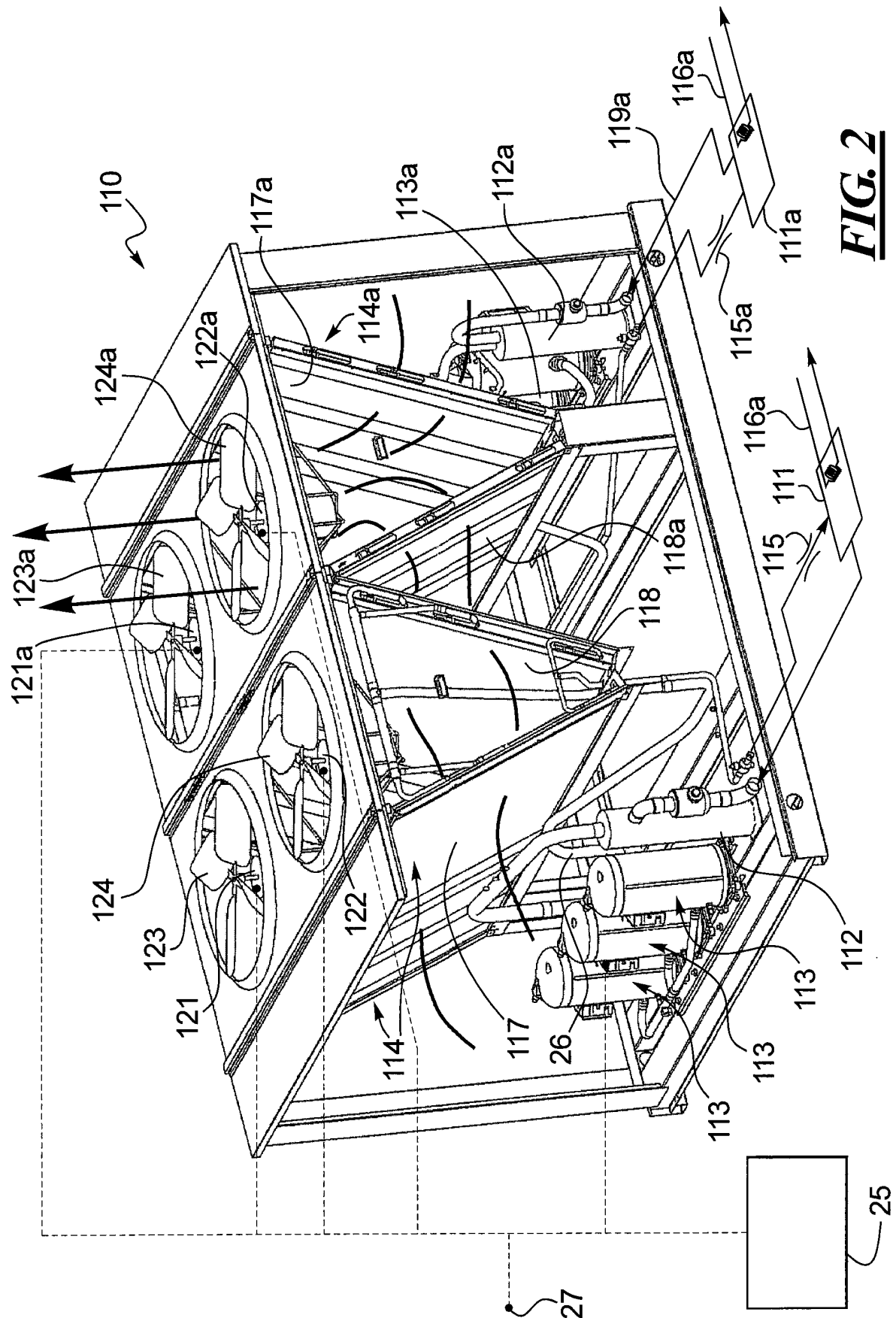


FIG. 2

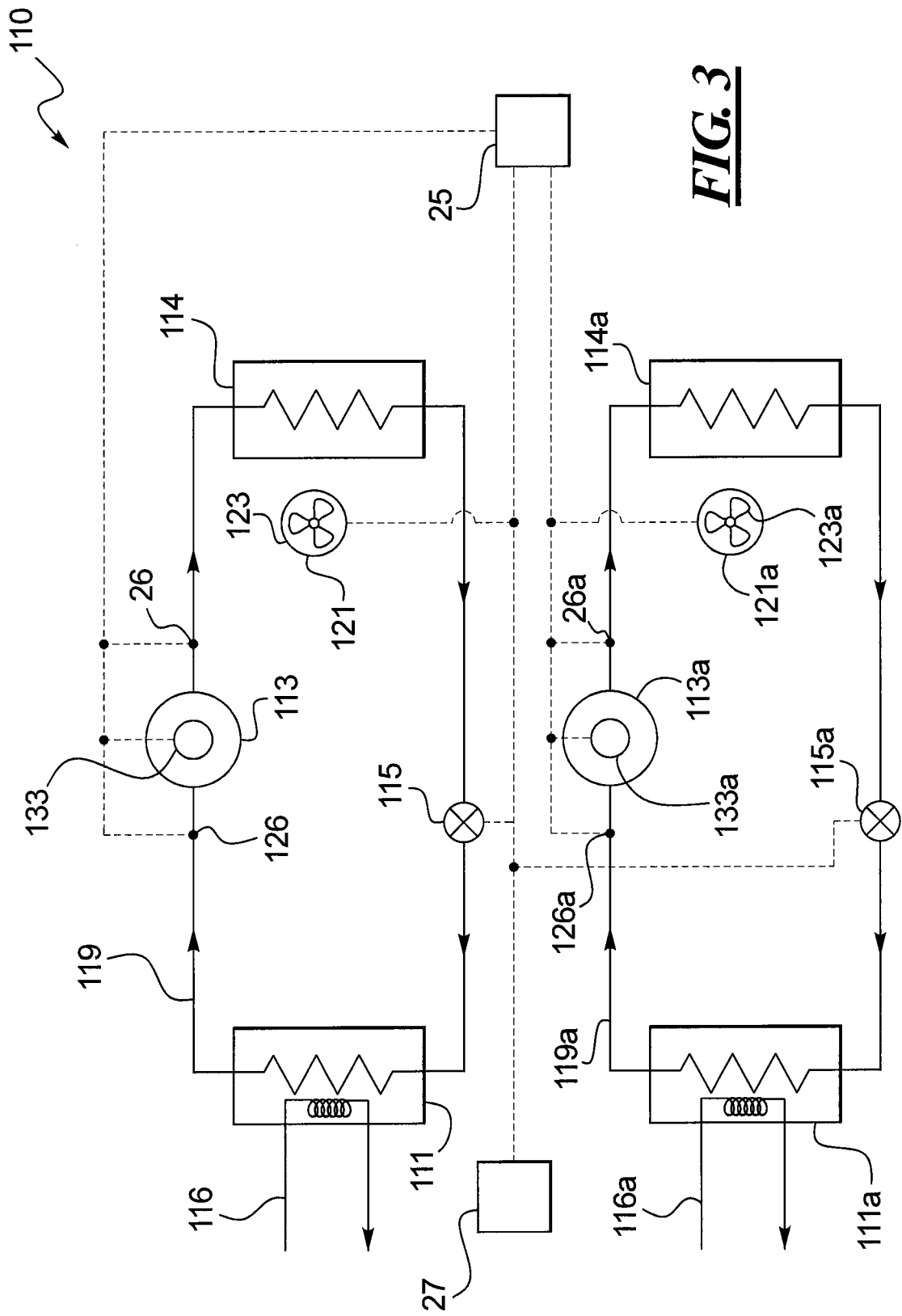
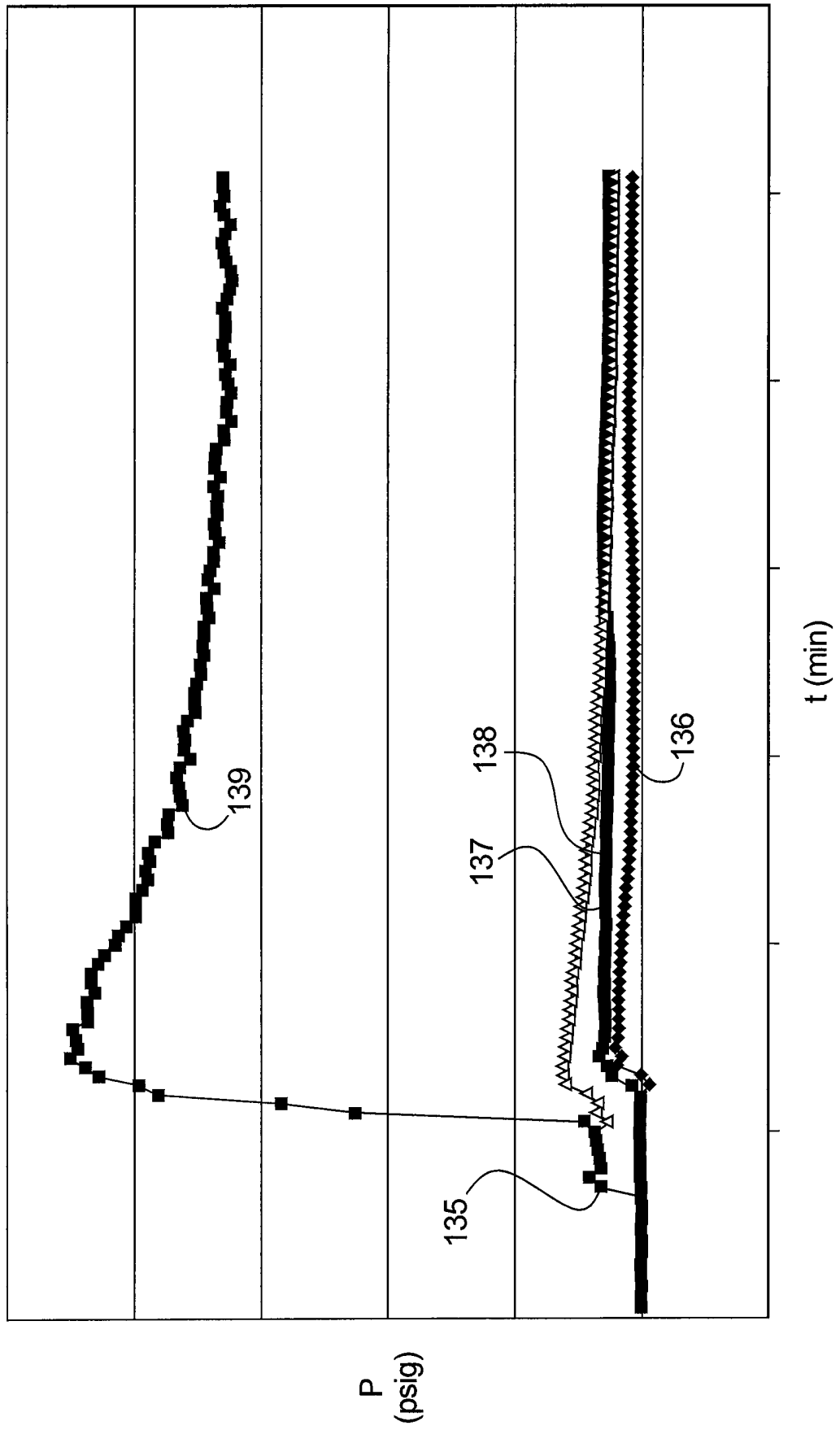


FIG. 3

FIG. 4



REFERENCES CITED IN THE DESCRIPTION

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